Magnetic Particle Imaging: A Novel Ultra-sensitive Imaging Scanner for Tracking Stem Cells In Vivo

Grant Award Details

Magnetic Particle Imaging: A Novel Ultra-sensitive Imaging Scanner for Tracking Stem Cells In Vivo

Grant Type: Tools and Technologies II

Grant Number: RT2-01893

Project Objective: The overall aim of the project is to develop magnetic particle imaging (MPI) as a means of tracking stem cells in vivo.

Investigator:

Name:	Steven Conolly
Institution:	University of California, Berkeley
Type:	PI

Human Stem Cell Use: Embryonic Stem Cell

Award Value: $1,311,596

Status: Closed

Progress Reports

Reporting Period: Year 1

View Report

Reporting Period: Year 2

View Report

Reporting Period: Year 3

View Report

Reporting Period: Year 4/NCE

View Report

Grant Application Details

Application Title: Magnetic Particle Imaging: A Novel Ultra-sensitive Imaging Scanner for Tracking Stem Cells In Vivo

Public Abstract: We aim to develop, test and validate a new, sensitive and affordable scanner for tracking the location of injected cells in humans and animals. This new scanning method, called Magnetic Particle Imaging, will ultimately be used to track the location and viability of stem cells within the human body. It could solve one of the greatest obstacles to human hESC therapy---the ability to track stem cells and see if the cells are thriving and becoming a cell that can improve function of damaged organs.

None of the current methods to track stem cells will be useful for tracking stem cells through a living human. MRI is too insensitive and expensive. While optical imaging methods (fluorescence and luminescence) are useful for cell studies under a microscope, they all cannot produce high resolution images deeper than a few mm. Nuclear imaging methods involve radiation and offer poor resolution. Ultrasound has many obstructions and the gas bubble stem cell tags do not persist very long. Hence, we wish to develop a new imaging method tailored for tracking stem cells in the human body---Magnetic Particle Imaging. Magnetic Particle Imaging has 200x better sensitivity compared to MRI, it will be significantly more affordable, and will require no expert operator. Only developed in the last year, Magnetic Particle Imaging scanners are not available commercially. Our expected resolution is 200 um with scan times of seconds per imaging slice. Initial in-vitro tests show promise that 200 cell detection is feasible. In fact, with industrial efforts on electronics and contrast agents, single cell detection may be feasible. The method employs FDA approved superparamagnetic nanoparticles (e.g., Resovist or Ferumoxtran) for Magnetic Particle Imaging.

Our specific aims are to (1) construct a Magnetic Particle Scanner for mice; (2) Optimize the MPI nanoparticle contrast agent for spatial resolution and sensitivity; (3) Validate the MPI scanner against histology with [REDACTED]; and (4) disseminate our designs to the stem cell community.

An affordable high-resolution, and quantitative stem cell scanner is absolutely critical for the field of stem cell therapy to progress to humans. Research on mESC is funded heavily by the NIH, but our research is motivated principally to track hESCs in humans and, hence, is very unlikely to be funded by the Federal Government.

Statement of Benefit to California:	Stem cell therapy has enormous promise to become a viable therapy for a range of illnesses, including cardiac disease, diabetes, stroke, and Parkinson's. If we could expedite the development of these therapies, it would be of enormous benefit to the citizens of California, since they and their relatives would enjoy far less disability. Moreover it would greatly reduce the Medicaid costs for the State. The diseases mentioned above are the leading cost illnesses as measured in lost productivity, lost wages, and extended care of the disabled. A study of the 1987 National Medicaid Expenditure Survey and the 2000 Medical Expenditure Panel Survey showed the 15 most costly medical conditions are (1) heart disease, 8%, (4) cancer, 5%; (5) hypertension, 4%; (7) cerebrovascular disease, 3.5%; and (9) diabetes, 2.5%. A key obstacle to stem cell therapy is the inability to track stem cells through a human body. This means that there is no way (other than measuring organ function) to determine how well the therapy works. Considering the number of delivery methods and the number of challenges to getting stem cells in place, and then coaxing them to differentiate and improve organ function, it will be impossible to optimize the entire process without quantitative imaging feedback to optimize each step. Unfortunately there is no acceptable method now for quantitative tracking of stem cells throughout the human body. Our new method, called Magnetic Particle Imaging, looks very promising for track stem cells in vivo. Moreover, it will be affordable and quite simple to operate. This research requires a collaboration between imaging instrument engineers, stem cell biologists, nanoparticle experts, and physicians. Fortunately, we have been able to form such a team between [REDACTED]. We also have formed a key collaboration with [REDACTED]. [REDACTED] is very excited by this bold research, which could open up an entirely new branch of diagnostic imaging technology for many medical applications. Hence, we are very excited to begin this research so the basic technology will be in place to help stem cell biologists work out the ideal protocols for stem cell therapies.